Space Weather Technical Forecast

Issued on Tuesday 24 September 2024 at 13:31 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: G1/Minor Geomagnetic Storm likely, mainly Day 2 (25 Sep) due to coronal hole high speed stream and a possible glancing blow CME. Chance of M-flares (R1-R2 Blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Moderate with a flare peaking at M1.3, at 23/1457 UTC from AR3836 with a contribution from AR3833. There are currently nine sunspot regions on the visible disc, with a new region developing north of AR3835. AR3833 in the northwest has been fading. AR3828 is also of note, but any opposite polarity spots have now faded. The new region on the southeast limb has been numbered AR3836 and remains very difficult to assess due to foreshortening near the limb, but is showing some notable looping in SDO imagery, so is one to watch. Remaining regions appear mostly small or simple at the present time.

A CME observed 22-23 Sep, directed primarily to the south and east, mostly away from Earth. However, analysis suggests a possible glancing blow on Day 2 (25 Sep), likely from the shock associated with the CME. No other Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE at L1, started at slightly elevated levels near 380 km/s, increasing to around 460 km/s. Density was below average. Interplanetary Magnetic Field, Bt, was moderate (with peaks of 12 nT) until around 24/0000 UTC when weak levels were resumed. The north-south component, Bz, was moderately southward directed for the first few hours, then rotating to become northward directed around 23/1535 UTC. Phi angle has been predominately negative (towards the Sun) until around 24/0200 UTC when it became positive (away from the Sun) . Geomagnetic activity was mostly Quiet to Unsettled (Kp 1-3), becoming Active (Kp 4) for one interval (23/1500-1800 UTC).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was mainly moderate, briefly touching high, with a peak of 1390 pfu at 23/1445 UTC, then dropped back to mostly background levels by The associated 24-hour fluence was initially above the Active threshold (1e8 integrated pfu), dropping below at the 23/1200 UTC observation. The 24/0000 UTC observation was 4.44e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with a chance of isolated M-class flares.

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Solar Wind / Geomagnetic Activity: The partial halo CME following the M3.7 flare off the southeast quadrant on 22 Sep may give a glancing blow at Earth on Day 2 with effects potentially lasting into Day 3 (25-26 Sep). This may coincide with the arrival of any CIR or connection to the fast wind from CH72/+. However, this aspect of the forecast is considered to be low confidence. Solar wind speeds are currently slightly elevated under the influence of what appears to be a weak transient CME, and are likely to remain so with the arrival of any connection to the fast wind from CH72/+. If we also experience a glancing blow from the above mentioned CME then solar winds could potentially become elevated.

Geomagnetic activity is forecast to be Quiet to Unsettled at first. If we see a combination of fast winds and CME influence on Days 2-3 then this will bring a likelihood of Active to G1/Minor Storm intervals. However, if we see more than just shock influence from the CME, then geomagnetic activity could become more significantly enhanced, with a slight chance of reaching G2-G3/Moderate-Strong Storm intervals. This is currently considered to be low confidence. Geomagnetic activity is likely to gradually ease to Quiet to Unsettled during Day 4 (27 Sep).

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is likely to remain at background levels. High energy electron flux at GOES16 is now at background to moderate levels with little change likely. Fluence probably remaining below the Active (1e8 integrated pfu) threshold. There is just a slight chance of fluence exceeding Active again in this period.

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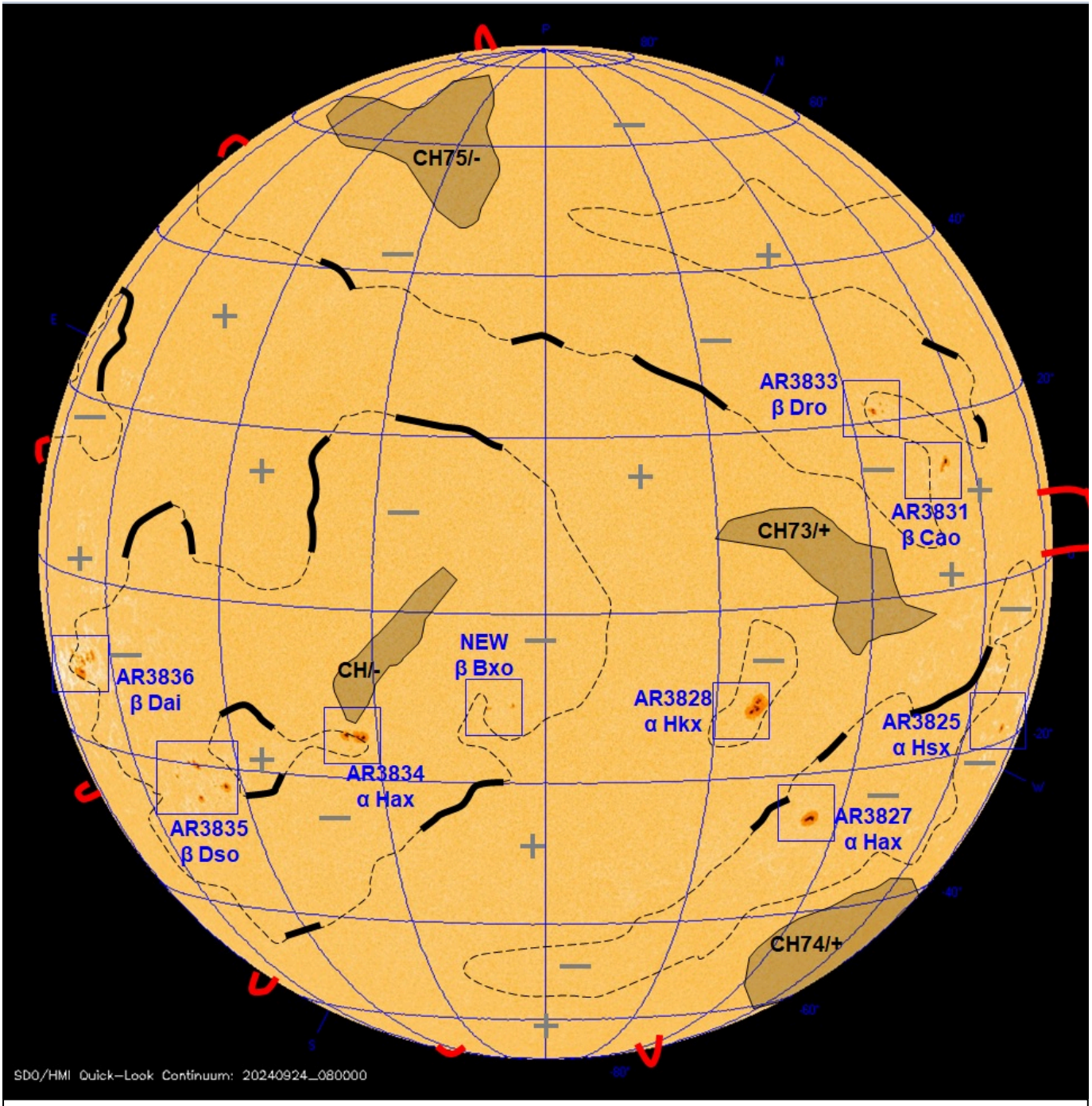
Figure 1: Latest Solar Synoptic Map valid 0800 UTC, 24 September 2024.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

The partial halo CME which was observed following the M3.7 flare off the southeast quadrant on 22 Sep has been analysed. Results suggest a possible glancing blow on Day 2 with effects potentially lasting into Day 3 (25-26 Sep). The bulk of the material appears to be heading below and behind Earth's orbit. However, coronagraph imagery suggests that some shock effects could reach Earth. This may coincide with the arrival of any CIR or connection to the fast wind from CH72/+. However, this is aspect of the forecast is considered to be low confidence.

Solar winds are currently slightly elevated and are likely to remain so with a connection to the fast wind from CH72/+. If we also experience a glancing blow from the above mentioned CME then levels could potentially become elevated. The coronal hole is a persistent feature and is in a generally similar location when compared to previous rotation, but is more defined and extends slightly further west on this occasion. However, on the previous rotation any impacts were largely swamped by ongoing CME effects. With the positive polarity of the coronal hole and the proximity of the September Equinox, this would suggest the possibility of some geomagnetic enhancement associated with this feature, although wind speeds did not go much above 400 km/s on the previous rotation and similar is likely this time. This largely fits with MOSWOC Enlil's forecast.

Geomagnetic activity is forecast to be Quiet to Unsettled at first. If we see a combination of CH72/+ fast winds and CME influence on Days 2-3 then this will bring a likelihood of Active to G1/Minor Storm intervals. However, if we see more than just shock influence from the CME, then geomagnetic activity could become more significantly enhanced, with a slight chance of reaching G2-G3/Moderate-Strong Storm intervals. This is currently considered to be low confidence. Geomagnetic activity is likely to gradually ease to Quiet to Unsettled during Day 4 (27 Sep).

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	60	30	10
Strong	G3	No	1	20	10	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Figure 2: Latest Met Office ENLIL ensemble output showing timings of potential CME arrival.

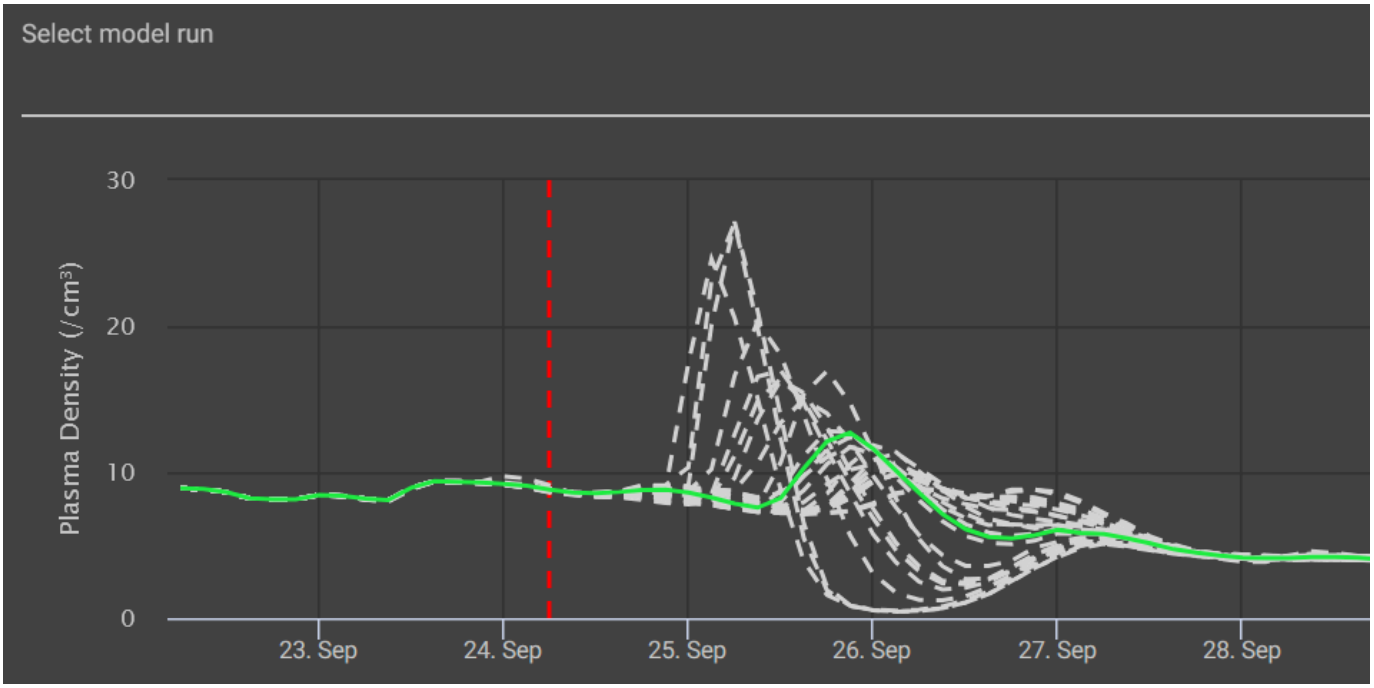
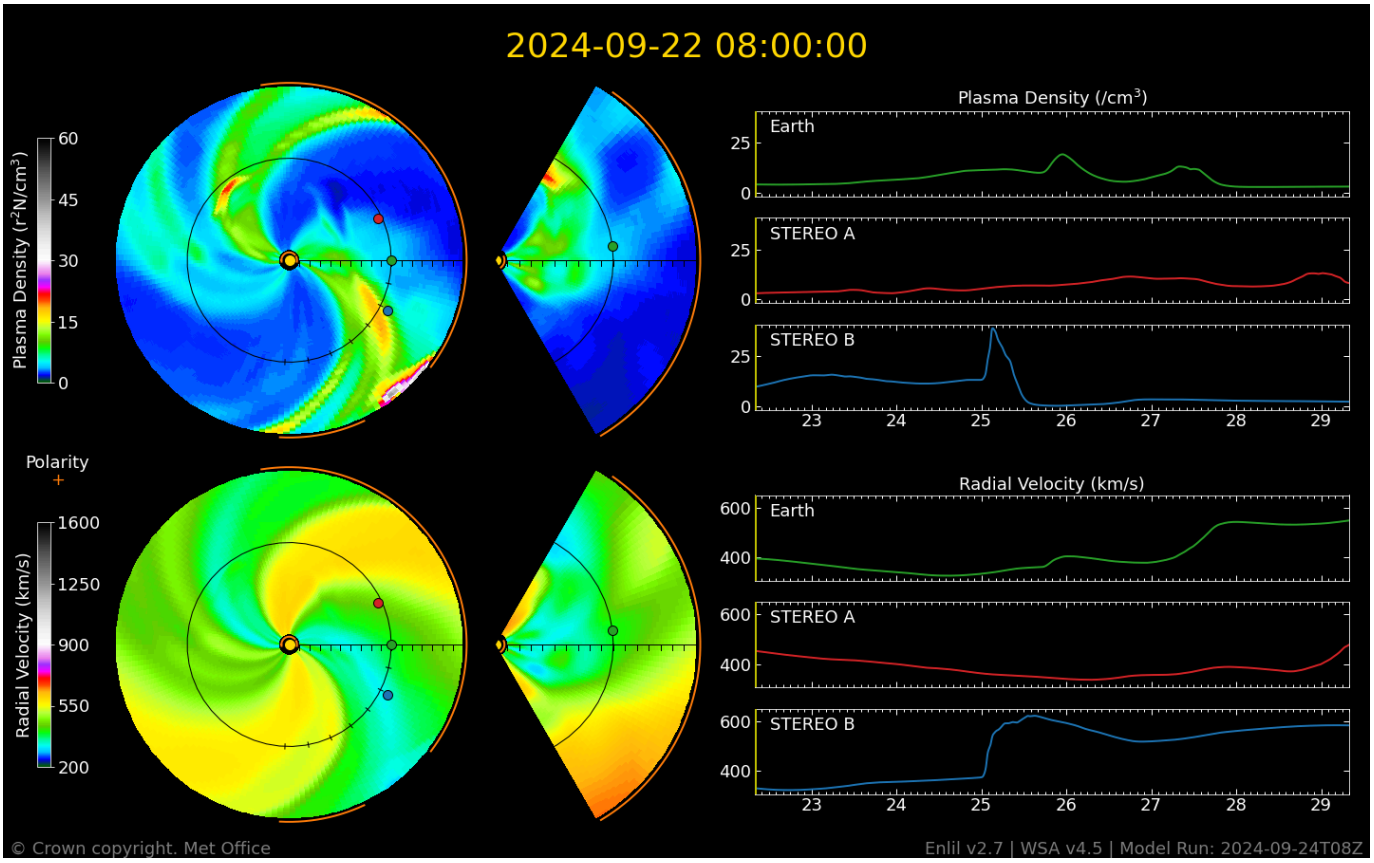


Figure 3: Latest Met Office ENLIL showing timings of potential CME arrival.



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Radio Blackouts - X-Ray Flares

Activity is Moderate with a flare peaking at M1.3, at 23/1457 UTC from AR3836 with a contribution from AR3833. Activity is expected to remain Low to Moderate, with a chance of isolated M-class flares, most likely from AR3828, AR3833, or AR3836.

Nine sunspot regions cover the visible disc. AR3833 in the northwest has lost its delta spot configuration. AR3828 is also of note, but any opposite polarity spots have now faded. AR3836 remains very difficult to assess due to foreshortening near the limb, but is showing some notable looping in SDO imagery, so is one to watch. Remaining regions appear mostly small or simple at the present time.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	50	50	50	50
Very Active	R3-R5 (X Class)	No	5	5	5	5

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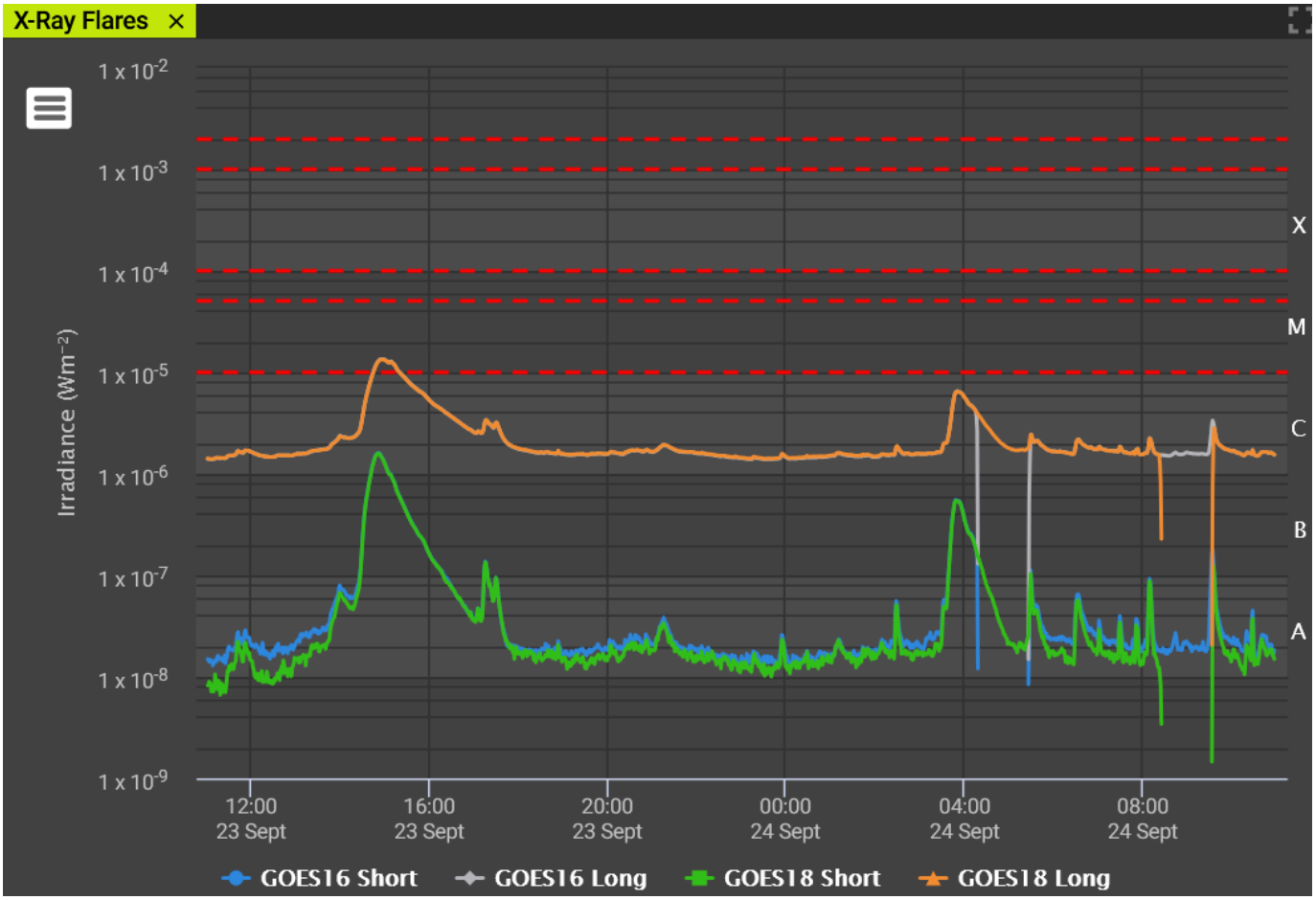
Figure 4: X-ray flux at GEO from GOES showing one M-class flare from yesterday (23 Sep).



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Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 is forecast to persist at background levels, with only a very slight chance of rising above the S1/Minor Radiation Storm threshold.

The majority of the sunspots on the disc are either small or simple. However the slight complexity apparent in AR3833 in the northwest results in a very slight chance of proton productive flares. There is also a non-zero, albeit very low chance of observable protons from any significant filament eruption, given the number and size of notable filaments currently on the disc.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

GOES-16 high energy electron flux is now at background to moderate levels. Due to potential HSS and CME effects, the subsequent increased solar wind pressure could compress the radiation belts once again. There is potential for another increase in flux later in the period, after CME and HSS effects have subsided.

The associated 24 hour fluence reached the Active (1e8 integrated pfu) level during 22-23 Sep but has since dropped below, likely due to the recent weak CME arrival. Confidence is low during this period, but it seems most likely that fluence will remain below the Active threshold on a declining trend at first, before potentially rising on Day 4 (27 Sep). MOSWOC REFM also suggests a gradual declining trend to the fluence, however until recently this has been consistently underestimating the observed fluence reducing confidence in this model guidance.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^{8}**	Yes	20	10	5	20
Very Active	**≥ 2 MeV ≥ 1×10^{9}**	No	1	1	1	1

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Figure 5: High energy electron flux at GEO from GOES and Met Office REFM output.

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